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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04N 17/00 — A1

(11) International Publication Number: WO 00/30366

(43) International Publication Date: 25 May 2000 (25.05.00)

(21) International Application Number: PCT/EP99/07908

(22) International Filing Date: 14 October 1999 (14.10.99)

(30) Priority Data:
98203894.5 17 November 1998 (17.11.98) EP

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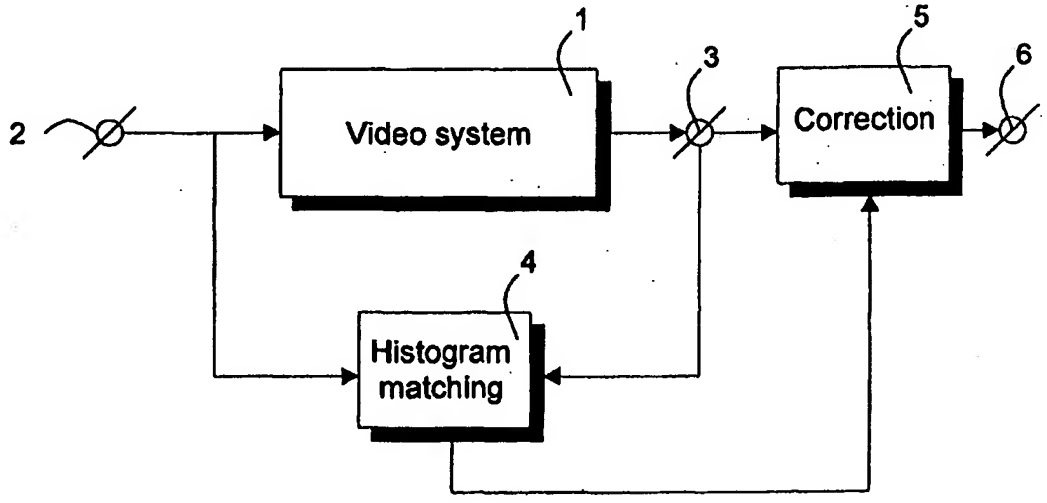
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: A METHOD AND AN ARRANGEMENT FOR ALIGNING INPUT AND OUTPUT VIDEO SEQUENCES FOR VIDEO QUALITY MEASUREMENT



(57) Abstract

A method of and an arrangement for aligning input (2) (Y–in; U–in; V–in) and output video sequences (3) (Y–out; U–out; V–out) of a video processing system (1), wherein histograms (4) are obtained representative of the occurrence of a plurality of discrete pixel values of pixels present in both the input and output video sequences (2; 3). Correction curves are obtained by matching the histograms (4) of the input and output video sequences (2; 3). By processing (5) the output video sequence (3) with the correction curves obtained, and comparing the input video sequence (1) and processed output video sequence (6), an objective video quality measure is obtained providing a closer match to a subjectively obtained video quality measure.

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Title

A Method and an Arrangement for Aligning Input and Output Video Sequences for Video Quality Measurement.

Field of the Invention

The present invention relates to video quality measurement and, in particular, to a method and an arrangement for aligning input and output video sequences of a video processing system such as a codec and video transmission channel.

Background of the Invention

In practice, video quality is measured by comparing, on a pixel by pixel basis, input and output video sequences of a video processing system.

If the system under test changes in a global manner the contrast, the luminance or the chrominance signal of the input video sequence, in that all the frames are transformed in a like manner, a test person will judge this as less disturbent than changes which are locally applied. Codecs which increase or decrease the brightness and contrast of the output signal without creating an annoying difference, are examples of such a system.

If the video processing system performs a simple linear transformation, the processed or degraded output signal can be relatively easily corrected by applying inverse transformation. In practical systems, the transformation of the video processing system is non-linear and complicated, such that an inverse transformation is not always applicable.

Quality measures which do not use inverse transformation will always show a lesser correlation than quality measures which do use a type of inverse transformation in order to compensate the video output sequence.

Uptil now, there is no generally applicable and perceptively justified manner of calculating the inverse transformation of a video processing system. A linear approach is most often used in practice, however, with the risk of a too less correlation between subjectively and objectively measured video quality. Further, video sequences are bounded signals. In case of an input signal having a large contrast compared to the output signal, transformation, if linear, would lead to a mapping out of the applicable range.

Summary of the Invention

The present invention aims to overcome the above disadvantages of the prior art by providing a method of aligning input and output video sequences of a video processing system, wherein histograms are obtained representative of the occurrence of a plurality of discrete pixel values of pixels present in both the input and output video sequences, and wherein a correction curve is obtained by matching the histograms of the input and output video sequences.

With the method according to the invention, a non-linear correction curve can be obtained, such as an S-type transformation curve of a video processing system.

By neglecting the correction curve, the objective quality measure obtained from the input and output video sequences will provide a too large difference, in those cases wherein a human observer will judge a difference in brightness and contrast, of an S-curve, not relevant for the quality of the video processing system under test.

In a preferred embodiment of the invention, the histograms are obtained by counting the cumulative relative occurrence of pixel values of the plurality of pixel values for each of the video sequences. That is, for each pixel value the cumulative percentage of occurrence in a video sequence is calculated, i.e. the sum is calculated of the percentages of the pixel values less than or equal

to the current pixel value. The plurality of pixel values preferably ranges from a first value equivalent to a black pixel upto a last value equivalent to a white pixel.

In an embodiment, the pixel values are taken from a bounded domain having values ranging from 0 = black to 255 = white and any intermediate integer value.

In a further preferred embodiment of the method according to the invention, the correction curve is obtained by matching pixel values of the histograms of the input and output video sequences of which the cumulative percentages are as equal as possible.

Starting from a pixel value in the histogram of the output video sequence, for example, it is not likely that their will exist a pixel value in the histogram of the input video sequence having exactly the same cumulative percentage. Accordingly, in a further embodiment of the invention, interpolation between pixel values of the histogram of the input video sequences is provided in order to obtain an exact match of the cumulative percentages. A linear interpolation provides suitable results.

By starting from the pixel value in the middle of the domain of pixel values of a histogram, matching problems due to small percentages or fractions are avoided.

According to the invention, correction curves may be obtained for any of the luminance and chrominance signals of the input and output video sequences.

By processing the output video sequence using the correction curve or curves obtained, and comparing the input video sequence and processed output video sequence a quality measure is obtained which matches in a optimum manner subjectively obtained video quality measures.

The invention relates further to an arrangement for performing the method described above, comprising means for obtaining histograms of both the input and output sequences, and means for matching the histograms to obtain a correction curve for a video signal.

The above and other features and advantages of the present invention will be readily apparent to one of ordinary skill in the art from the following written description when read in conjunction with the drawing.

Brief Description of the Drawings

Figure 1 shows, in a schematic representation, a video system of which the video quality has to be measured.

Figure 2 shows, in a schematic representation, an embodiment of an arrangement according to the invention used with the video system shown in figure 1.

Detailed Description of the Embodiments

The video system 1 of figure 1 represents video processing systems such as a codec, a video transmission channel, etc. Input terminal 2 receives an input or source video sequence, generally comprising a luminance input signal Y-in and chrominance input signals U-in and V-in. Output terminal 3 of the video system 1 provides an output video sequence, comprised of the output luminance signal Y-out and output chrominance signals U-out and V-out.

Dependent on the type of video system 1 and its transformation function, the video sequence at the output terminal 3 is distorted or degraded compared to the input video sequence at the input terminal 2.

Video quality is measured by comparing the input and output video sequences, using video quality measurement equipment (not shown).

In order to obtain an as optimum as possible correlation between subjectively judged video quality, that is by one or more test persons looking to both the input and output video sequences, and the objectively measured video quality with the video quality measurement equipment, it is necessary to correct the output luminance and chrominance signals by a correction curve or curves, which depend on the input and output luminance and chrominance values.

In order to obtain such a correction curve or curves, according to the invention, histograms are obtained representative of the occurrence of discrete pixel values of pixels in both the input and output video sequences, i.e. the input and output luminance and chrominance signals. By matching the histograms thus obtained, the required correction curve or curves can be provided.

To this end, in figure 2, histogram matching means 4 are shown, generally comprising suitably programmed processing equipment, for obtaining the histograms.

In a preferred embodiment of the invention, the histograms are obtained by counting the cumulative percentage of occurrence of each of the pixel values in the input and output video sequences. The term cumulative denotes that the sum is calculated of the percentages of the pixel values less than or equal to the current pixel value. It is assumed that each pixel that is counted in the histograms is present in both the input and the output video sequences. From the histograms thus provided, a correction curve is obtained by matching pixel values of the histograms having the same or as optimum as possible the same cumulative percentage of occurrence.

Assume a pixel having the value x and a cumulative percentage y in the histogram of the output video sequence. The means 4 are now programmed such that in the histogram of the input video sequence the pixel value x' is obtained having the cumulative percentage y' which is the same or as best as possible the same as the cumulative percentage y. The correction curve is obtained by mapping x and x'. This procedure is repeated for the pixel values x+1, x+2, etc, such that all or nearly all the pixel values are mapped.

It will be understood that in general there is no exact match of the cumulative percentages y and y'. In such a case, in order to obtain an exact match, the invention provides for interpolation between the pixel values of the histogram of the input video sequences, providing a pixel value x''. The correction curve is than obtained by mapping x and x''.

In a preferred embodiment of the invention, the discrete pixel values range from the value 0, equivalent to a black pixel, uptil 255 which is

equivalent to a white pixel. Any intermediate integer value in this domain represents a pixel value.

In order to avoid calculation of low percentages, it is preferred to start the matching process of the histograms in the middle of the domain, i.e. pixel value 128. By this, calculation too small fractions are avoided. At the pixel value 128, the risk of a non-zero percentage is small. By this calculation proceeding towards the ends of the pixel value domain one can ressort to a straight curve once the percentages are becoming too small.

Although any type of interpolation is feasible, linear interpolation has found to provide satisfactory results.

By processing the video output sequence at the output terminal 3 of the video system 1, as schematically indicated by means 5 in figure 2, a processed video output sequence at an output terminal 6 is provided. For obtaining a quality measurement, according to the invention, the input video sequence at input terminal 1 and the processed output video sequence at output terminal 6 are fed into a video quality measurement device (not shown). The video quality measure thus obtained has a much better correlation with subjectively established video quality measures than without the processing of the output video sequence using the correction curve or curves according to the invention.

Those skilled in the art will appreciate that for the luminance and chrominance video signals different correction curves may be obtained, adapted to the characteristics of the video systems and/or perceptive measures.

Although the matching of the histograms has been described starting from the output video sequence, it will be understood that the correction curves may also be obtained by starting from the input video sequence.

Claims

1. A method of aligning input and output video sequences of a video processing system, wherein histograms are obtained representative of the occurrence of a plurality of discrete pixel values of pixels present in both said input and output video sequences, and wherein a correction curve is obtained by matching said histograms of said input and output video sequences.

2. A method according to claim 1, wherein said histograms are obtained by counting the cumulative relative occurrence of pixel values of said plurality of pixel values for each video sequence.

3. A method according to claim 2, wherein said plurality of pixel values ranges from a first value equivalent to a black pixel up to a last value equivalent to a white pixel.

4. A method according to claim 3, wherein said pixel values are taken from a bounded domain having values ranging from 0 = black to 255 = white and any intermediate integer value.

5. A method according to any of the previous claims, wherein said correction curve is obtained by matching pixel values of said histograms of said input and output video sequences of which the cumulative relative occurrences are as equal as possible.

6. A method according to claim 5, wherein interpolation between pixel values of the histogram of the input video sequence is provided in order to obtain an exact match of the cumulative percentages of the histograms of the input and output video sequences.

7. A method according to claim 5 or 6, wherein said matching starts from the pixel value in the middle of the domain of pixel values.

8. A method according to any of the previous claims, wherein separate correction curves are obtained for any of the luminance and chrominance signals of the input and output video sequences.

9. A method according to any of the previous claims, wherein said output video sequence is processed by the correction curve(s) obtained, and

wherein said input video sequence and processed output video sequence are compared to provide a video quality measure.

10. An arrangement for aligning input and output video sequences of a video processing system, comprising means for obtaining histograms of both said input and output video sequences, and means for matching said histograms to obtain a correction curve.

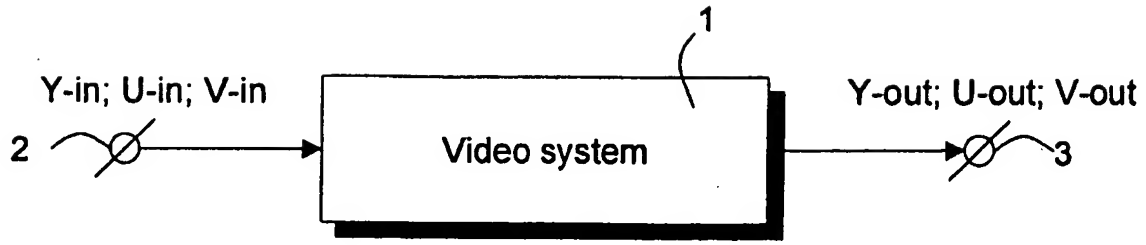
1
Y-in; U-in; V-in
2
Video system
Y-out; U-out; V-out
3

Fig. 1

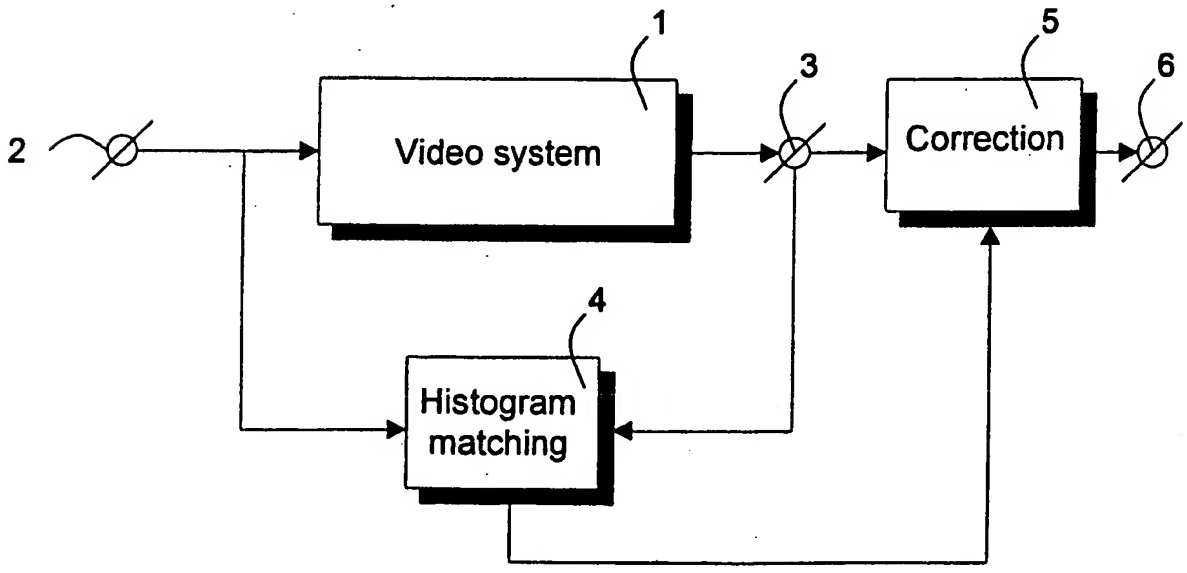
1
3
5
6
2
Video system
Correction
4
Histogram matching

Fig. 2

INTERNATIONAL SEARCH REPORT

Inter. ...nal Application No
PCT/EP 99/07908

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04H H04N G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 329 379 A (RODRIGEZ A. ET AL) 12 July 1994 (1994-07-12) the whole document ---	1-4,10
A	US 5 727 080 A (COX I. ET AL) 10 March 1998 (1998-03-10) the whole document ---	1-5,10
A	US 4 450 482 A (ACKERMAN R.) 22 May 1984 (1984-05-22) the whole document ---	1-5,10
A	EP 0 801 360 A (SAMSUNG ELECTRONICS CO. LTD.) 15 October 1997 (1997-10-15) the whole document ---	1-5,10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
20 December 1999	13/01/2000

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INTERNATIONAL SEARCH REPORT

Interr. nal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 838 960 A (ELOP ELECTRO-OPTICS INDUSTRIES LTD) 29 April 1998 (1998-04-29) the whole document	1,10
A	US 5 446 492 A (WOLF S. ET AL) 29 August 1995 (1995-08-29) the whole document	1,10
A	US 5 596 364 A (WOLF S. ET AL) 21 January 1997 (1997-01-21) column 4, line 23 -column 14, line 56	1,10
A	US 5 214 507 A (ARAVIND R. ET AL) 25 May 1993 (1993-05-25) column 15, line 3 - line 33	1,10
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2

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/EP 99/07908

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EP 869686 A	07-10-1998	JP 10290471 A	27-10-1998

NOTICE OF PRELIMINARY REJECTION

ADDRESSEE:

APPLICANT(S): BRITISH TELECOMMUNICATIONS plc

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Mapo-Gu, Seoul
KOREA

APPLICATION NO. : Korean Patent Application No. 7024367/2005

TITLE OF THE INVENTION: METHOD AND SYSTEM FOR VIDEO QUALITY ASSESSMENT

We do hereby decide that the above application shall be rejected for the following grounds for rejection. If you disagree, you may file an Amendment and/or Arguments by December 25, 2010.

GROUNDS FOR REJECTION

Please see the attached sheet.

October 25, 2010

Examiner : Gyun-Su, Kim
Digital Broadcasting Examination Division
Information & Communications Examination Bureau

THE KOREAN INTELLECTUAL PROPERTY OFFICE

-REASONS-

Rejected claims: 1-35
Patentable claims: None

1. The inventions described in all claims are vague under Article 42, Paragraph 4 of the Korean Patent Act as set forth below.

Claims 1 and 20 do not recite any objects for matching, for example histogram, pixel, PSNR and the way and condition of generating the video quality value. Thus claims 1 and 20 are indefinite.

In claims 1 and 20, the expressions "field/frame" is vague. For example, it is vague as to whether the reference video field corresponds to the test video field or the test video frame.

In claims 2 and 21, it is vague as to what the M1 and M2 mean and if the M1 and M2 are integers.

The expression "and/or" in claims 2, 7, 9, 21, 26 and 28 is vague.

The computer program invention of claim 17 and the modulate carrier signal invention of claim 18 are not patentable, since they cannot be classified into an apparatus claim nor a method claim.

Claim 16 is dependent on claim 14 but claim 14 does not recite an "offset value".

Claims 5-16 are not patentable under Article 42, Paragraph 5 of the Korean Patent Act, because they are multiple dependent claims which quote other multiple dependent claims.

2. The inventions of claims 1-11 and 17-30 (hereinafter referred to as the present invention) are not patentable in view of cited reference 1 (WO 2003010952) and cited reference 2 (WO 2000030366) under Article 29, Paragraph 2 of the Korean Patent Act as set forth below:

The present invention is directed to a video quality assessment method.

The reference discloses a matching technique using a variety of video comparing methods (pixel by pixel comparison, PSNR, Full reference approach, MAD and etc.) and video quality analysis and measures using the result thereof.

The inventions of claim 2 and 3 are easily conceivable in view of the reverse frame prediction of cited reference 1 and the forward prediction technique that is well-known in the art.

The inventions of claim 4 and 5 are easily conceivable in view of the video quality analysis and assessment using the decomposition of cited reference 1.

The invention of claim 6 is easily conceivable in view of the definition of the pattern for test of cited reference 1.

The inventions of claims 7-11 are fully disclosed in cited reference 2.

The inventions of claims 17-30 are substantially identical with the above claims.